

CLAIMS

What is claimed is:

1. A method for determining the volume of a biological sample held within an electrochemical biosensor, comprising:
 - applying an alternating voltage having a selected amplitude and a selected frequency to the biosensor;
 - measuring the current generated by applying said alternating voltage;
 - determining the capacitance of the biosensor from said measured current;
 - determining the surface area of the biosensor in contact with the sample based on said determined capacitance; and
 - determining the volume of the sample within the biosensor based on said determined surface area.
2. The method of claim 1 further comprising determining whether said sample volume is adequate for measuring one or more selected characteristics of said sample.
3. The method of claim 2 further comprising measuring the concentration of one or more selected analytes present within said sample measurement based on a determination that said sample volume is adequate.
4. The method of claim 2 further comprising:
 - determining the necessary compensation factor to compensate for said inadequate volume based on a determination that said sample volume is inadequate; and
 - compensating for said inadequate sample volume.
5. The method of claim 4 wherein determining the necessary compensation factor comprises determining the ratio of the capacitance of the biosensor when completely filled with said sample to the capacitance of the biosensor with said inadequate sample volume.
6. The method of claim 1 further comprising determining the resistance of the biosensor from said measured current.

7. The method of claim 6 further comprising determining the surface area of the biosensor in contact with the sample based on said determined capacitance and said determined resistance.

8. The method of claim 1 further comprising applying a direct current voltage to said biosensor.

9. The method of claim 8 wherein said direct current voltage and said alternating current voltage are applied simultaneously.

10. The method of claim 1 wherein said electrochemical biosensor comprises at least two electrodes forming an electrochemical cell having a cell volume and wherein said determined surface area is a surface area of said at least two electrodes covered by said biological sample.

11. The method of claim 1 wherein said amplitude of the applied AC voltage is selected such that it does not result in a Faradic current within the biosensor.

12. The method of claim 11 wherein said amplitude is the range from about 2 to 100 mV rms.

13. The method of claim 12 wherein said amplitude is about 50 mV rms.

14. The method of claim 1 wherein said frequency of said applied AC voltage is selected such that the ratio of the equivalent cell capacitance to the variability of the equivalent cell capacitance of the biosensor is maximized.

15. The method of claim 14 wherein said frequency is in the range from about 50 to 10,000 Hz.

16. The method of claim 15 wherein said frequency is about 100 Hz.

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17. The method of claim 8 wherein said direct current voltage is in the range from about 0 to 600 mV.

18. A method for compensating for an inadequate volume of a biological sample held within an electrochemical biosensor for measurement of at least one characteristic of said biological sample, comprising determining the ratio of the capacitance of the biosensor when completely filled with said sample to the capacitance of the biosensor with said inadequate sample volume.

19. A method for measuring at least one characteristic of a biological sample held within an electrochemical biosensor, comprising:

determining the volume of said biological sample;

determining adequacy of the volume of said biological sample;

compensating for an inadequate volume of a biological sample held within an electrochemical biosensor based on a determination that said volume is inadequate; and accurately measuring the at least one characteristic of said biological sample.

20. The method of claim 19 wherein said at least one characteristic is the concentration of one or more selected analytes present within said sample.

21. The method of claim 19 wherein compensating for an inadequate volume comprises determining the ratio of the capacitance of the biosensor when completely filled with said sample to the capacitance of the biosensor with said inadequate sample volume.

22. The method of claim 21 wherein determining said ratio comprises accessing the value of said capacitance of the biosensor when completely filled within said sample from the memory storage means of a microprocessor.

23. A system for determining the volume of a biological sample within an electrochemical cell having a surface area and a volume, comprising:
a voltage supply configured for applying a voltage to said electrochemical cell;
means for measuring a current generated by said cell when said voltage is applied to said cell;

means for deriving the capacitance of said cell from said measured current;

means for deriving the surface area of said cell covered by said biological sample from said cell capacitance; and

means for deriving the volume of said biological sample from said cell surface area.

24. The system of claim 23 further comprising means for determining whether said sample volume is adequate for making an accurate measurement of the concentration of one or more selected analytes within said biological sample.

25. The system of claim 24 further comprising:

means for measuring the concentration of one or more selected analytes within said biological sample; and

means for compensating for said sample volume determined to be inadequate while measuring the concentration of one or more selected analytes within said biological sample.

26. The system of claim 25 further comprising means for displaying the measured concentration of one or more selected analytes within said biological sample.

27. A system for use with a meter configured for engaging an electrochemical cell and measuring the concentration of one or more selected analytes within a biological sample held within the electrochemical cell, said system comprising:

a voltage supply configured for applying an alternating and/ or a direct current voltage to said cell; and

an electronic circuit configured for receiving a current generated by said electrochemical cell when a voltage is applied to said cell, measuring said generated current, determining the capacitance of said cell from said measured current, determining the surface area of said cell covered by said biological sample from said cell capacitance, and determining the volume of said biological sample from said cell surface area covered by said biological sample.

28. The system of claim 27 wherein said electronic circuit is further configured for determining whether said sample volume is adequate for making an accurate measurement of one or more selected physical or chemical characteristics of said biological sample.

29. The system of claim 28 wherein said electronic circuit is further configured for compensating for said sample volume determined to be inadequate while measuring one or more selected physical or chemical characteristics of said biological sample.

30. The system of claim 29 wherein said electronic circuit is further configured for displaying said one or more measured characteristics of said biological sample.

31. The system of claim 27 wherein said electronic circuit comprises a microprocessor.

32. A system for measuring selected characteristics of a biological sample held within a test strip, comprising;

a meter configured to receive said test strip and comprising a voltage supply configured for applying an alternating and/or a direct voltage to said test strip; and

a microprocessor electronically coupled to said meter and comprising:

- (i) means for storing data related to said test strip, said biological sample, calibration and performance parameters of said meter;
- (ii) means for receiving a current generated by said electrochemical test strip when a voltage is applied to said test strip;
- (iii) means for measuring said generated current; and
- (iv) means for determining the volume of said biological sample from said test strip surface area covered by said biological sample based on said measured current.

33. The system of claim 32 wherein said microprocessor further comprises means for determining the adequacy of said sample volume and means for compensating for an inadequate volume of said sample in measuring a selected characteristic of said sample.

34. A kit for determining the volume of a biological sample within an electrochemical cell, comprising:

a system according to claim 23; and

instructions for using said system according to the method of claim 1.

35. The kit of claim 34 further including an automated device integral with said system configured to operatively receive and engage said electrochemical cell for determining one or more physical or chemical characteristics of the biological sample.

36. An electronic circuit configured for operatively receiving and engaging an electrochemical cell configured to hold a biological sample, said circuit comprising:

means for measuring a current generated by said cell;

means for deriving the capacitance and resistance of said cell from said measured current;

means for deriving the surface area of said cell covered by said biological sample from said cell capacitance or from the ratio of said cell capacitance to said cell resistance; and

means for deriving the volume of said biological sample from said cell surface area.

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